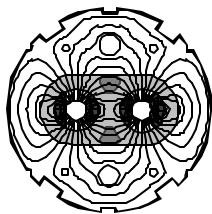


**CERN**

CH-1211 Geneva 23  
Switzerland



the  
**Large  
Hadron  
Collider**  
project

*LHC Project Document No.*

**LHC-DFBX\_-ES-230.00 rev 0.8-draft**

*CERN Div./Group or Supplier/Contractor Document No.*

**LH 20 00**

*EDMS Document No.*

Date: 22 February 2001

## Interface Specification

# DFBX - LBX

### *Abstract*

This specification establishes the detailed interface requirements between the DFBX and the superconducting D1. This specification applies to the DFBX at IR2 (left and right), and IR8 (left and right).

***Prepared by :***

**J. Zbasnik**, AFRD/LBNL

[Jzbasnik@lbl.gov](mailto:Jzbasnik@lbl.gov)

**C. A. Corradi**, LBNL

[CACorradi@lbl.gov](mailto:CACorradi@lbl.gov)

**S. Plate**, BNL

[Plate@bnl.gov](mailto:Plate@bnl.gov)

***Checked by :***

**J. Strait**, FNAL

[Strait@fnal.gov](mailto:Strait@fnal.gov)

**W.C. Turner**, FNAL

[Wcturner@lbl.gov](mailto:Wcturner@lbl.gov)

***Approved by :***

### *History of Changes*

<i>Rev. No.</i>	<i>Date</i>	<i>Pages</i>	<i>Description of Changes</i>
0.1 – draft	11 Mar 2000		Initial Draft
0.2 – draft	28 July 2000	5	Corrections to Table 4.1-1
		16	Updated paragraph 4.10.2.
		17	Updated Table 5.2-1, warm up heater; Section 7 Drawings
0.3 – draft	19 Sept 2000	4	Added Equipment Code section; rearranged mechanical interface paragraphs.
		5-8	Added Figure 4.2-1; updated Tables 4.3-1, 2, 4.4-2 and 4.6-2.
		17	Deleted Section 7.
		All	Added comments/corrections from informal review.
		5	Updated Figure 4.2-1 and drawing list.
		6-9	Updated Tables 4.3-1 and 2, 4.4-1 and 2, and 4.6-1 and 2.
		11	Combined Tables 4.8-2 and 3.
0.4– draft	7 Nov 2000	17	Updated Table 5.2-1.
		4	Updated Coordinate System section, added Table 2-1.
		4-18	Updated references; added appendix.
		11	4.9.1 noted “CERN provided bellows”.
0.5 – draft	21 Dec 2000	4	Added Section 2, Interconnect Responsibilities
		7	Added Figure 5.2-2
		8 – 17	Misc. edits, figures revised and added; deleted Sec. 7; added Sec. 2
0.6 – draft	31 Jan 2001	8	Updated Tables 5.3-1, 2
		11	Updated Tables 5.8-2
		15	Added Figure 5.9-5
		17	Added Figure 6.1-2, updated Table 6.2-1
0.7 – draft	9 Feb 2001	All	Misc. edits
0.8 – draft	22 Feb 2001	4	Updated Table 2-1.
		8	Updated Tables 5.3-1, 2
		11	Updated Tables 5.8-1, 2
		17	Removed ref. [8] from Sec. 6.1
		All	Misc. edits

## *Table of Contents*

<b>1.</b>	<b>INTRODUCTION .....</b>	<b>4</b>
<b>2.</b>	<b>INTERCONNECT RESPONSIBILITIES .....</b>	<b>4</b>
<b>3.</b>	<b>CO-ORDINATE SYSTEM.....</b>	<b>4</b>
<b>4.</b>	<b>CRYOGENIC FLOW SCHEMATICS .....</b>	<b>5</b>
<b>5.</b>	<b>MECHANICAL INTERFACES .....</b>	<b>5</b>
5.1	EQUIPMENT CODES.....	5
5.2	DRAWINGS SHOWING TRANSVERSE DFBX PIPING LOCATIONS .....	5
5.3	CRYOGENIC PIPING IDENTIFICATION .....	7
5.4	TRANSVERSE LOCATIONS OF CRYOGENIC PIPING – LEFT SIDE .....	9
5.5	TRANSVERSE OFFSET FOR LEFT-SIDE INSTALLATION .....	10
5.6	TRANSVERSE LOCATIONS OF CRYOGENIC PIPING – RIGHT SIDE.....	10
5.7	TRANSVERSE OFFSET FOR RIGHT-SIDE INSTALLATION .....	10
5.8	LONGITUDINAL MOVEMENT OF CRYOGENIC PIPING .....	10
5.9	CRYOGENIC PIPING CONNECTION DETAILS .....	12
5.9.1	BEAM TUBE CONNECTION.....	12
5.9.2	BUS DUCT CONNECTION.....	12
5.9.3	1.9K PUMPING LINE CONNECTION.....	13
5.9.4	COOLDOWN/VENT (LD1) PIPING CONNECTIONS .....	14
5.9.5	THERMAL SHIELD COOLING (EX AND E2) CONNECTIONS .....	15
5.9.6	BEAM SCREEN COOLING AND 1.9K SUPPLY (CC'2, CC'3, CY2) .....	15
5.10	THERMAL SHIELD BRIDGE CONNECTION DETAILS.....	16
5.11	VACUUM VESSEL CONNECTION DETAILS .....	16
5.11.1	SEALING FLANGE .....	16
5.11.2	STRUTS FOR VACUUM LOADING.....	16
<b>6.</b>	<b>ELECTRICAL INTERFACES .....</b>	<b>17</b>
6.1	MAGNET BUS BARS .....	17
6.2	MAGNET DIAGNOSTICS.....	18
<b>7.</b>	<b>DRAWINGS .....</b>	<b>18</b>
<b>8.</b>	<b>REFERENCES .....</b>	<b>19</b>
<b>9.</b>	<b>APPENDIX A – DEFINITION OF DFBX LOCAL COORDINATES .....</b>	<b>20</b>

## 1. INTRODUCTION

This specification establishes the detailed mechanical and electrical interface requirements between the DFBX and the superconducting D1. This specification applies to DFBXC (IP2 Left), DFBXD (IP2 Right), DFBXG (IP8 Left), and DFBXH (IP8 Right). The interfaces defined herein must be consistent with the applicable interfaces in the D1 Interface Specification [1]. Interface requirements between the DFBX and the warm D1 are covered in the DFBX to beam tube interface specification [2].

## 2. INTERCONNECT RESPONSIBILITIES

**Table 2-1. Interconnect components and institutional responsibilities.**

Component	Connecting Components	Drawing Number	Responsible Laboratory
DFBX Assembly	N/A	TBD	LBL
DFBX thermal shield bridge	DFBX to D1	TBD	LBL
Instrumentation line flex hose	i to MBX2	TBD	LBL
Shield line bellows	e1 - Ex, e2 - E2	5520-MC-390056 [a]	LBL
Flanges for shield lines	e1, e2, Ex, E2	5520-MC-390035 [b]	LBL
Cool down bellows	c - LD1	5520-MC-390061 [c]	LBL
Cool down line flange	c, LD1	5520-MC-390033 [d]	LBL
Beam tube bellows	V - V	TBD	CERN
Beam screen supply flex hose	c' - CC'2	TBD	LBL
Heat exchanger inner tube flex hose	cy, cy <sub>t</sub> - CY2	TBD	LBL
Flange weld rings	N/A	TBD	LBL
LBX Assembly	N/A	TBD	BNL
Electrical soldering equipment	N/A	N/A	CERN
LBX vacuum bellows closure and flange	DFBX - LBX	TBD	BNL
Vent transfer line bellows	xb <sub>t</sub> , xb - XB	TBD	BNL
Cold mass bellows	m/c - MBX1	01055055 [e]	BNL
Flange	m/c line	12140089 [f]	BNL
Flange	i line	14010306 [g]	BNL

## 3. CO-ORDINATE SYSTEM

The local coordinate systems used in this specification are given in the DFBX General Interfaces Specification [3], and shown in Appendix A.

The origins of the DFBX local coordinate systems with respect to the CERN global coordinates are listed in Table 2-1. These locations are derived from the referenced CERN drawings and the flange to flange separation between the DFBX and the LQX of 510 mm [4].

**Table 3-1. Position of DFBX Local Coordinate Systems**

Code	Distance (mm) from IP	CERN Dwg. No.	Dwg. Ref. List
DFBXC	55052 Left of IP2	LHCLSX_0003D	[h]
DFBXD	55052 Right of IP2	LHCLSX_0004D	[i]
DFBXG	55052 Left of IP8	LHCLSX_0015D	[j]
DFBXH	55052 Right of IP8	LHCLSX_0016D	[k]

## 4. CRYOGENIC FLOW SCHEMATICS

The cryogenic flow schematics for the D1 magnets are shown on drawing LHCDFBX\_0001 [l]. This drawing shows the connection of all inner triplet superconducting magnets to the CERN cryogenic distribution line for all eight DFBX's.

The cryogenic piping connections allow for:

- Thermal shield supply and return connections,
- D1 cooldown and initial filling from the low point,
- 1.9K supply to the high end of the magnet heat exchanger,
- 1.9K return from the low end of the magnet heat exchanger, and
- Quench venting from both ends of the D1 magnet cold mass, LD1 and LD3 via MBX1.

The piping is consistent with the D1 Cooling Specification [5].

## 5. MECHANICAL INTERFACES

### 5.1 EQUIPMENT CODES

Because each of the eight DFBX may have a unique design, the following equipment codes have been adopted facilitating a direct application of the LHC documentation system. In the table, "IRnR" signifies the right side of the Interaction Point n, and IRnL signifies the left side of Interaction Point n.

Location	IR2L	IR2R	IR8L	IR8R
Code	DFBXC	DFBXD	DFBXG	DFBXH

### 5.2 DRAWINGS SHOWING TRANSVERSE DFBX PIPING LOCATIONS

The transverse locations and other features of the mechanical components of the DFBX-LBX interface at room temperature are defined in the drawings listed in Table 5.2-1. The features shown in these drawings are a planar section, taken at the plane of the vacuum vessel as seen from D1. Figures 5.2-1 and 2 show typical planar section views.

Table 5.2-1 Drawings showing DFBX Transverse Piping Dimensions

Location	LBNL Drawing No.	CERN No.	Drawing List
IR2L & IR8L	24C3236	LHCDFBX_0010	[m]
IR2R & IR8R	24C3246	LHCDFBX_0011	[n]

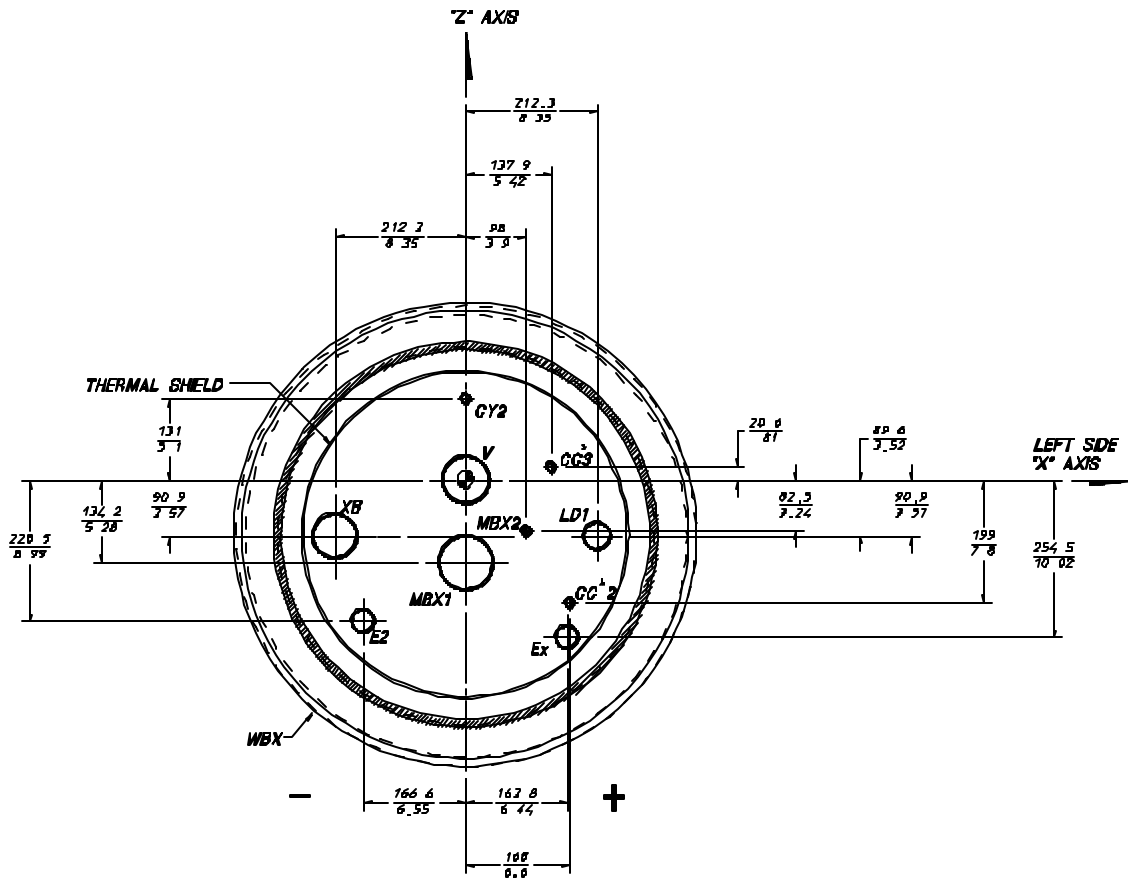


Figure 5.2-1. Typical left side DFBX transverse planar section at the DFBX exit flange as seen from D1. (Dimensions are mm/in.)

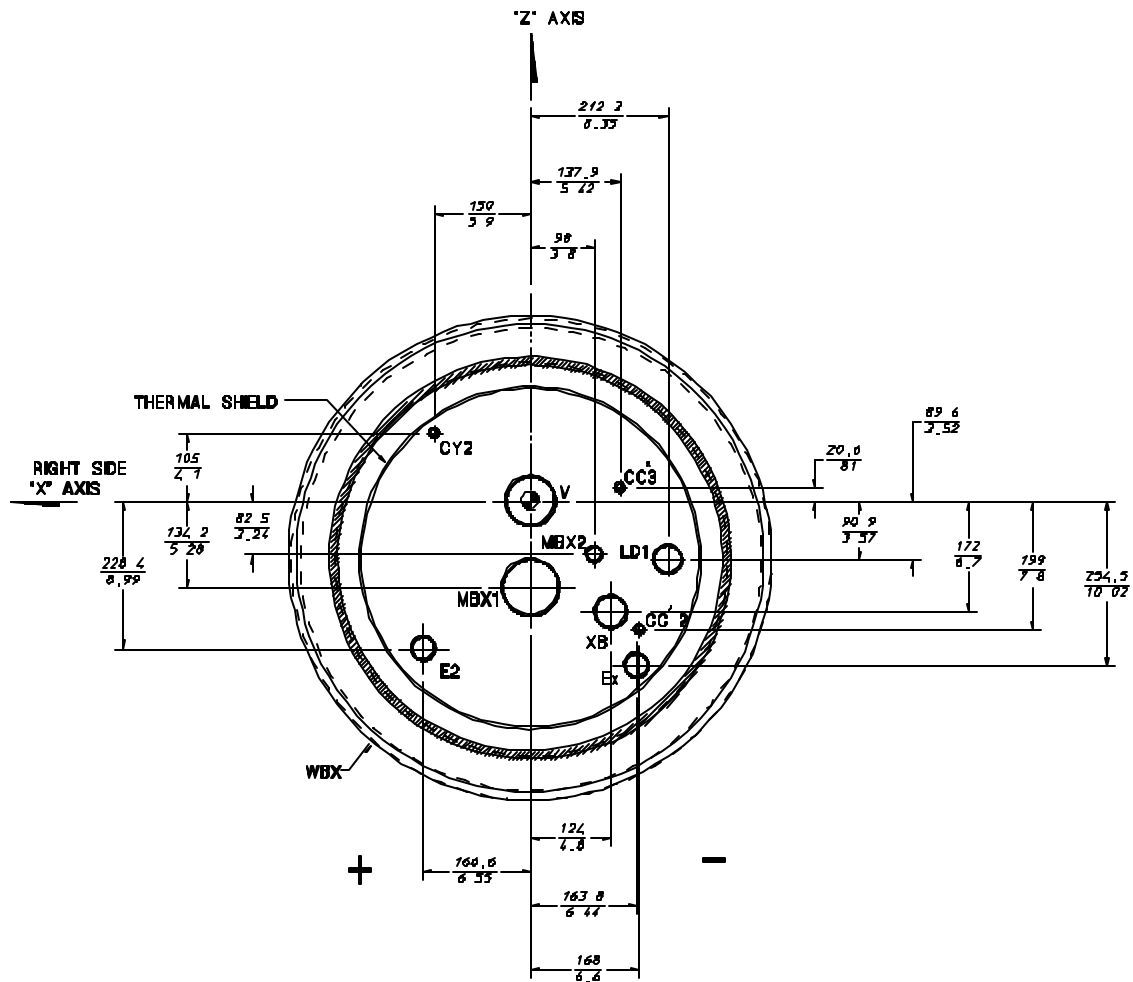
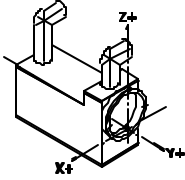


Figure 5.2-2. Typical right side DFBX transverse planar section at the DFBX exit flange as seen from D1. (Dimensions are mm/in.)

### 5.3 CRYOGENIC PIPING IDENTIFICATION

Table 5.3-1 lists the cryogenic pipes in the left-side DFBX (DFBXC and DFBXG) and the designations of the pipes in the LBX to which they are each connected. The (x,z) co-ordinates shown are those of the pipes in the DFBX at room temperature.

Table 5.3-2 lists the cryogenic pipes in the right-side DFBX (DFBXD and DFBXH) and the designations of the pipes in the LBX to which they are connected. The (x,z) co-ordinates shown are those of the pipes in the DFBX at room temperature.



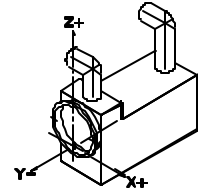
(DFBX reference coordinate system.)

Table 5.3-1 DFBX Left Side Piping Connections

Cryogenic Pipe Designation		Pipe OD/ID	Pipe Co-ordinates at 300 K		
LBX <sup>f</sup>	DFBX <sup>e</sup>	mm	X, mm $\pm 2$	Z, mm $\pm 2$	Y <sup>g</sup> , mm $\pm 2$
V	V	78/74	0	0	-109.5
c	LD1	44.4/41.9	212.3	-90.9	-101.5
c'	CC'2	15.9/13.4	168	-199	-377
Not Shown <sup>a</sup>	CC'3	15.9/13.4	137.9 <sup>b</sup>	20.6 <sup>b</sup>	-377
cy	CY2	15.9/13.4	0	131	-377
cy <sub>t</sub>	Not Req'd <sup>c</sup>	Not Req'd <sup>c</sup>	----	----	----
e1	Ex	38.1/34.8	163.8	-254.5	-56.5
e2	E2	38.1/34.8	-166.6	-228.5	-56.5
m/c	MBX1	88.9/85.6	0	-134.2	-114.4
i	MBX2	12.7/9.4	98	-82.5	-367
W	WBX	750/597	0	-89.6	0
xb	Not Req'd <sup>d</sup>	----	----	----	----
xb <sub>t</sub>	XB	73.0/68.8	-212.3	-90.9	-113.6

## Notes:

- Beam screen cooling return to be provided later by CERN. See LHC-DFBX\_-ES-220 [2].
- Beam screen cooling return location. See LHC-DFBX\_-ES-220 [2].
- DFBX 1.9K supply is connected to line cy for this side.
- DFBX 1.9K return is connected to line xb<sub>t</sub> for this side.
- Labels per LHCDFBX\_0001, cases DFBXC and DFBXG [I].
- Labels from LBX Dipoles – D1 interface specification [1].
- Dimension is from DFBX flange face on D1 side; add -2367.2 mm to reference Y from DFBX coordinate system origin.



(DFBX reference coordinate system.)

Table 5.3-2 DFBX Right Side Piping Connections

Cryogenic Pipe Designation		Pipe OD/ID	Pipe Co-ordinates at 300 K		
LBX <sup>f</sup>	DFBX <sup>e</sup>	mm	X, mm $\pm 2$	Z, mm $\pm 2$	Y <sup>g</sup> , mm $\pm 2$
V	V	78/74	0	0	109.5
c	LD1	44.4/41.9	-212.3	-90.9	101.5
c'	CC'2	15.9/13.4	-168	-199	377



Not Shown <sup>a</sup>	CC'3	15.9/13.4	-137.9 <sup>b</sup>	20.6 <sup>b</sup>	377
cy	Not Req'd <sup>c</sup>	----	----	----	-----
cy <sub>t</sub>	CY2	15.9/13.4	150	105	377
e1	Ex	38.1/22.1	-163.8	-254.5	56.5
e2	E2	38.1/22.1	166.6	-228.4	56.5
m/c	MBX1	88.9/85.6	0	-134.2	114.4
i	MBX2	12.7/9.4	-98	-82.5	367
W	WBX	750/597	0	-89.6	0
xb	XB	50.8/47.5	-124.	-172.	113.6
xb <sub>t</sub>	Not Req'd <sup>d</sup>	----	----	----	-----

Notes:

- Beam screen cooling return to be provided later by CERN. See LHC-DFBX\_-ES-220 [2].
- Beam screen cooling return location. See LHC-DFBX\_-ES-220 [2].
- DFBX 1.9K supply is connected to line cy<sub>t</sub> for this side.
- DFBX 1.9K return is connected to line xb for this side.
- Labels from LHCDFBX\_0001, cases DFBXD and DFBXH [1].
- Labels from LBX Dipoles – D1 interface specification [1].
- Dimension is from DFBX flange face on D1 side; add 2367.2 mm to reference Y from DFBX coordinate system origin.

## 5.4 TRANSVERSE LOCATIONS OF CRYOGENIC PIPING – LEFT SIDE

Table 5.4-1 lists the transverse locations of the DFBX cryogenic piping at operating and room temperatures. The cold locations of the DFBX piping are nominally within  $\pm 2$  mm of the cold locations of their counterparts in the LBX [1].

**Table 5.4-1, Transverse Locations of Left-side DFBX Piping<sup>a</sup>**

DFBX Pipe No.	Cold Locations <sup>b</sup>		Warm Locations	
	X	Z	X	Z
LD1	211.7	-91.9	212.3	-90.9
CC'2	167.5	-198.5	168	-199
CY2	0.0	131.6	0.0	131.0
Ex	163.1	-252.6	163.8	-254.5
E2	-166.1	-228.9	-166.6	-228.5
MBX1	0.0	-133.9	0.0	-134.2
MBX2	97.7	-82.3	98.0	-82.5
WBX	0.0	-87.7	0.0	-89.8
XB	-211.7	-91.4	-212.3	-90.9

Notes:

- DFBX Beam tube axis moves 0.2 mm in negative z-direction upon cooldown, moving the DFBX coordinate system origin down 0.2 mm. There is no shift in the x-direction upon cooldown.
- Cold coordinates above are relative to the DFBX cold beam tube.

## 5.5 TRANSVERSE OFFSET FOR LEFT-SIDE INSTALLATION

To ensure proper match of the beam tube and other cryogenic piping at operating temperature, the DFBX beam tube will be positioned 1.7 mm lower than the LBX beam tube at installation at room temperature.

## 5.6 TRANSVERSE LOCATIONS OF CRYOGENIC PIPING – RIGHT SIDE

Table 5.6-1 lists the transverse locations of the DFBX cryogenic piping at operating and room temperatures. Note that the cold locations of the DFBX piping are nominally within  $\pm 2$  mm of the cold locations of their counterparts in the LBX [1].

**Table 5.6-1 Transverse Locations of Right-side DFBX Piping<sup>a</sup>**

DFBX Pipe No.	Cold Locations <sup>b</sup>		Warm Locations	
	X	Z	X	Z
LD1	-211.7	-91.4	-212.3	-90.9
CC'2	-167.5	-199.5	-168	-199
CY2	149.6	104.7	150	105.0
Ex	-163.1	-252.6	-163.8	-254.5
E2	166.1	-227.7	166.6	-228.4
MBX1	0.0	-129.8	0.0	-130.2
MBX2	-97.7	-82.3	-98.0	-82.5
WBX	0.0	-87.7	0.0	-89.6
XB	-123.6	-171.5	-124	-172

Notes:

- The DFBX beam tube moves 0.2 mm in negative z-direction upon cooldown, moving the DFBX coordinate system origin down 0.2 mm. There is no shift in the x-direction upon cooldown.
- Cold co-ordinates above are relative to the DFBX cold beam tube.

## 5.7 TRANSVERSE OFFSET FOR RIGHT-SIDE INSTALLATION

To ensure proper match of the beam tube and other cryogenic piping at operating temperature, the DFBX beam tube will be positioned 1.7 mm lower than the LBX beam tube at installation at room temperature.

## 5.8 LONGITUDINAL MOVEMENT OF CRYOGENIC PIPING

The longitudinal interconnection regions between the LBX and DFBX are shown on CERN layout drawings of the Long Straight Sections [h-k]. The drawings also show a CERN-defined virtual interconnect plane.

Upon cooling to operational temperature, the cryogenic piping connections between the LBX and DFBX will move apart because of thermal contraction. The amount of thermal contraction will be determined by the amount of temperature change, the thermal contraction coefficient, and the lengths of the pipes involved.

The expected thermal motion of the cryogenic piping in the LBX-DFBX interface is given in table 5.8-1. In the table, the free lengths are measured from the virtual interconnect plane as defined by CERN [h-k]. Bellows are required to allow this motion, and the column "total change" is the required stroke that the bellows must provide. Lines without bellows have flexible hoses or expansion loops.

**Table 5.8-1 Longitudinal Motion Upon Cooling To Operational Temperature**

DFBX Pipe No.	Free Length on LBX Side (mm)	Change on LBX Side	Total Change	Change on DFBX Side	Free Length on DFBX Side (mm)
V	5373	16.1	20.3	4.2	1398
LD1	5373	16.1	17.9	1.8	584
CC'2	5373	16.1	17.9	1.8	584
CC'3	5373	16.1	20.3	4.2	1398
CY2	5373	16.1	17.9	1.8	584
Ex	5373	16.7	20.9	4.2	1398
E2	5373	16.1	17.9	1.8	584
MBX1	5373	16.1	20.3	4.2	1398
MBX2	5373	16.1	17.9	1.8	584
XB	5373	16.1	23.0	6.9	2284

Table 5.8-2 lists design parameters and geometry of the required bellows. The bellows were used to develop the layouts in Section 5.9. At installation, the bellows are compressed by 50% of the stroke to obtain a minimum theoretical life expectancy of 2000 cycles. The end treatment of the bellows allows the assembly to be installed with an automatic, orbital welding machine when space permits. The end tubes are long enough to allow the bellows assembly to be reused after at least 4 removals.

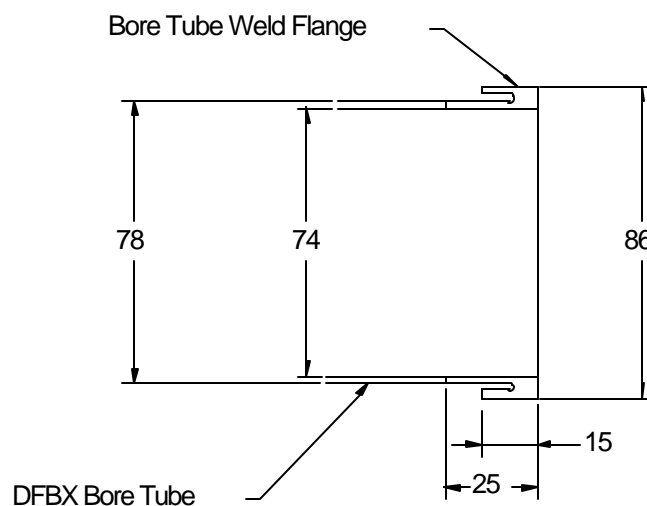
**Table 5.8-2, LBX-DFBX Bellows Design Parameters Fix up req'd strokes**

DFBX Pipe No.	ID (mm)	OD (mm)	Int. Des. Pres. bar	End Tube Parameters ID x wall x length (mm)	Comp. Length (mm)	Free Length (mm)	Reqd Stroke (mm)	Ref. Dwg. List
V	88.9	109.2	0	88.9 x 0.889 x 76.2	83.8	101.6	20.3	tbd
LD1	57.7	73.7	20	57.2 x 0.889 x 76.2	231.0	250.0	17.9	[c]
CC'2				Loop/ Flexible hose			17.9	tbd
CC'3				Loop/ Flexible hose			20.3	tbd
CY2				Loop/ Flexible hose			17.9	tbd
Ex	47.6	62.2	22	47.6 x 0.889 x 76.2	231.0	250.0	20.9	[a]
E2	47.6	62.2	22	47.6 x 0.889 x 76.2	231.0	250.0	17.9	[a]
MBX1	90.4	103.1	19	RHIC Bellows	241.0	254.0	20.3	[e]
MBX2				Flexible Hose			17.9	tbd
XB	57.2	69.9	tbd	BNL Bellows	208.0	220.0	23.0	tbd

## 5.9 CRYOGENIC PIPING CONNECTION DETAILS

### 5.9.1 BEAM TUBE CONNECTION

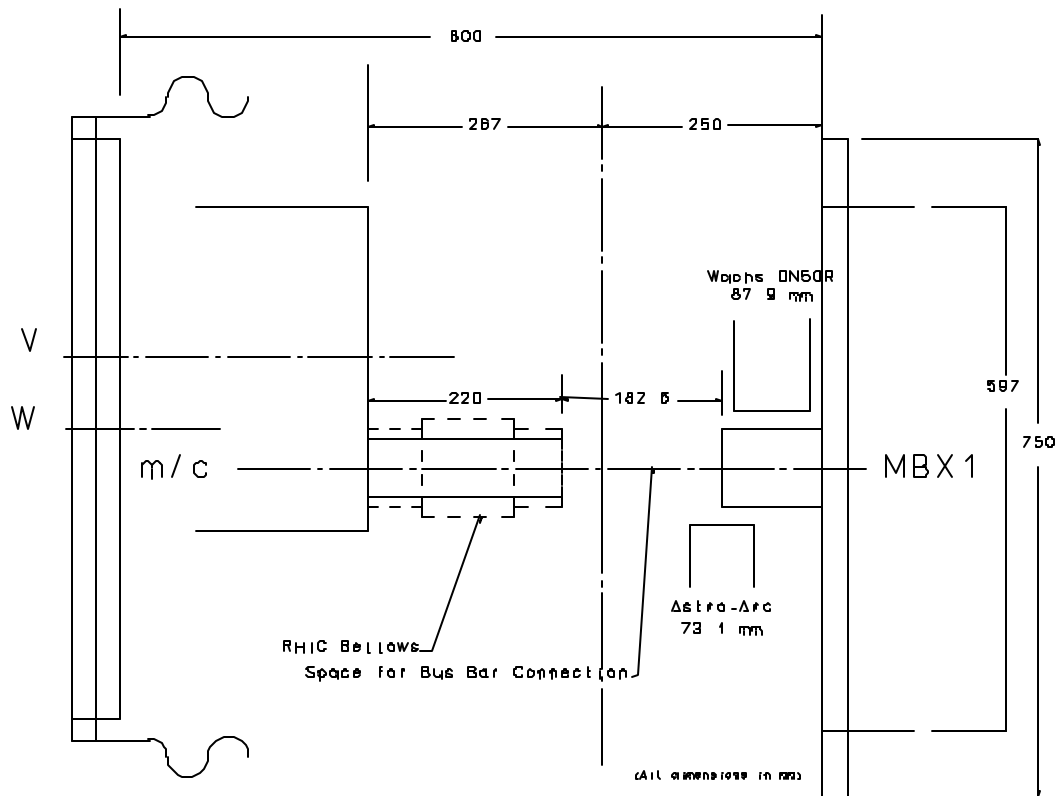
The D1 bore tube is to be fitted with CERN-supplied hardware that provides a beam screen with cooling. The end of the bore tube will be fitted with a provision for beam screen cooling connections and be terminated in a flange to allow the interconnecting bellows to be welded. The flange on the D1 side is 209.3 mm from the end volume of D1. The flange on the DFBX side will be 109.5 mm past the DFBX vacuum flange. The DFBX bore tube will be fitted with a weld flange as shown in Figure 5.9-1. The sliding RF joint supplied by CERN will be located in the region between these two flanges. After the sliding joint is installed, the CERN provided beam tube bellows is slid into position and is sealed by welding. Details of the beam tube connection are given in LHC-DFBX-ES-220 [2].



**Figure 5.9-1 DFBX Bore Tube Weld Flange.**

### 5.9.2 BUS DUCT CONNECTION

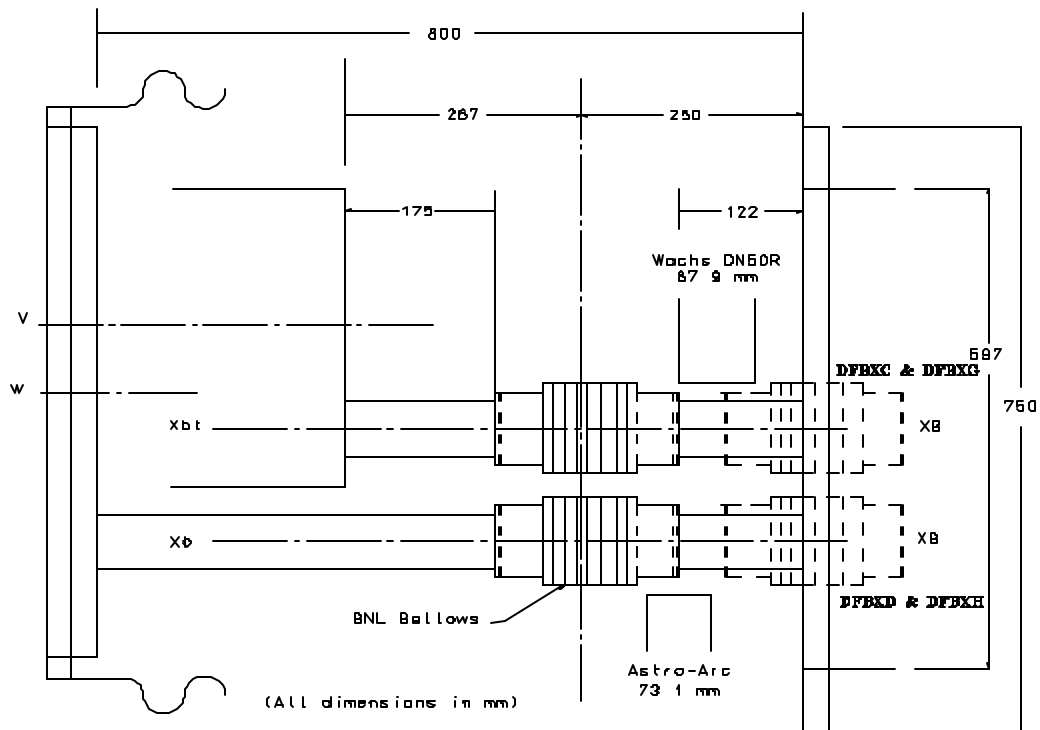
Figure 5.9-2 shows the layout of the interconnection between the m/c duct in D1 and the MBX1 duct in the DFBX. The bellows assembly is slid back on the D1 end while the electrical connections are made in the 183-mm-long open space. (The bus electrical connection details are given in Section 6.1 below). After the electrical connections are made, the bellows is slipped over weld flange on the m/c pipe onto the stub end of the MBX1 duct and then welded in place.



**Figure 5.9-2 D1-DFBX Bus Duct Connection Layout**

### 5.9.3 1.9K PUMPING LINE CONNECTION

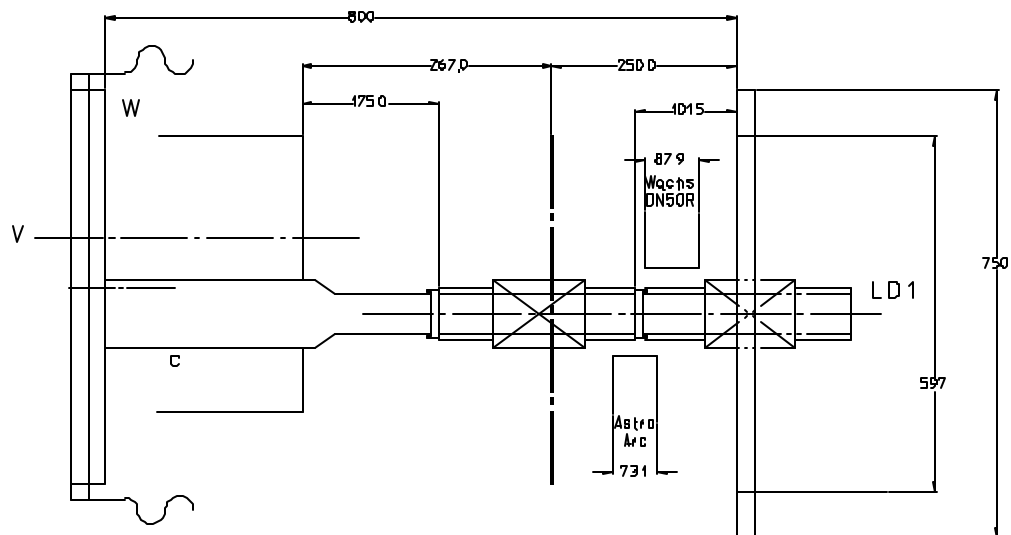
Figure 5.9-3 shows the interconnection layout for the XB lines. We show both types of XB connections in the Figure. Even though the XB diameters on the left and right sides of the IP differ, a common bellows assembly will be used for both. A transition flange will be used for the smaller diameter tube connection.



**Figure 5.9-3 XB Pumping Line Interconnection Layout**

#### 5.9.4 COOLDOWN/VENT (LD1) PIPING CONNECTIONS

The interconnection between the c line in the LBX and LD1 in the DFBX is shown in Figure 5.9-4. The bellows assembly is stored on the DFBX piping while the DFBX is installed. The bellows assembly is slid into position and welded to the special flanges using the orbital welding machine. In case the joint needs to be cut apart, the CERN cutting machine (Wachs DN50R) is used as shown in the figure.



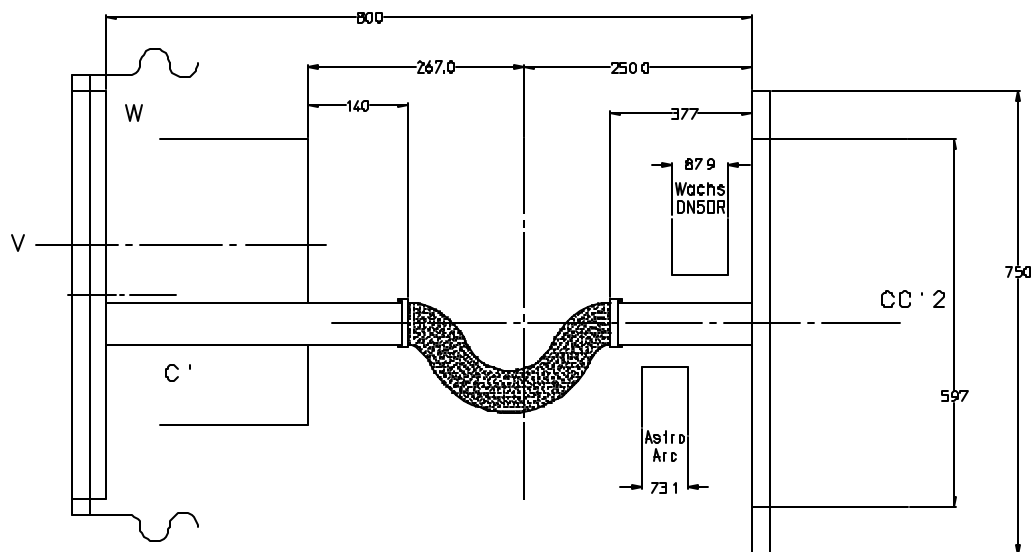
**Figure 5.9-4. LD1 Interconnection Layout.**

#### 5.9.5 THERMAL SHIELD COOLING (EX AND E2) CONNECTIONS

These connections are similar to the LD line interconnection and will be made with bellows listed in Table 5.8-2. The bellows length and longitudinal dimensions are listed in Tables 5.3-1, 5.3-2 and 5.8-2.

#### 5.9.6 BEAM SCREEN COOLING AND 1.9K SUPPLY (CC'2, CC'3, CY2)

These small diameter lines will have expansion loops or flexible hose rather than bellows and the piping will be simply butt-welded using an orbital welder of suitable size. See Figure 5.9-5.



**Figure 5.9-5. Beam screen cooling and 1.9 K supply layout. (Typical for CC' and Cy lines.)**

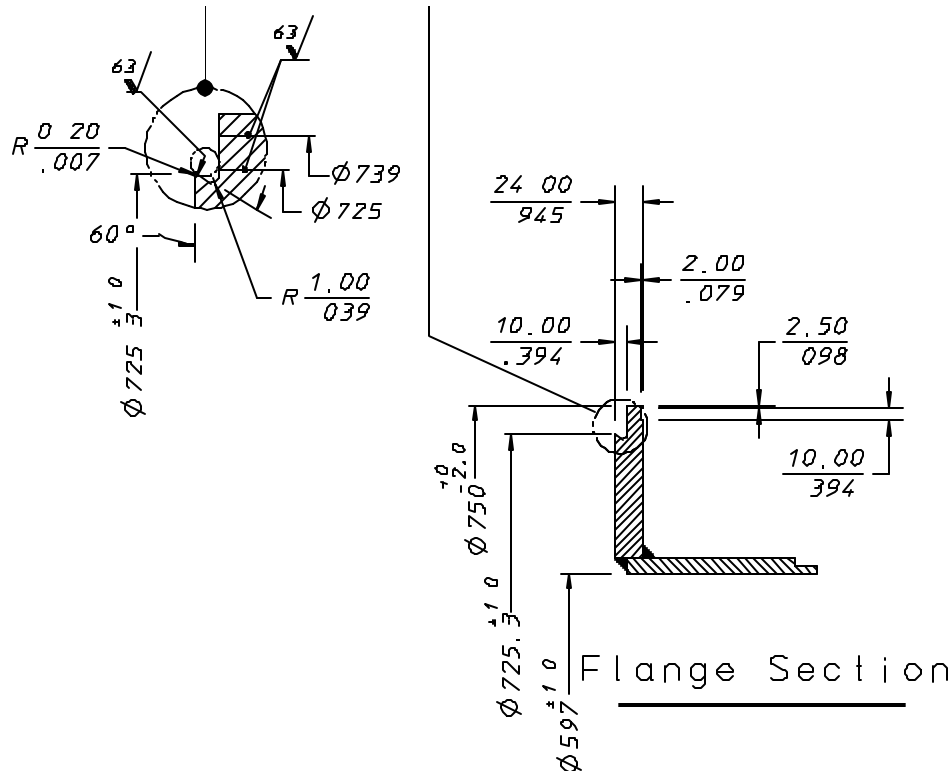
## 5.10 THERMAL SHIELD BRIDGE CONNECTION DETAILS

The thermal shield bridge will be fabricated in two parts, upper and lower halves, bolted together over the piping in the interconnect region using a clam shell design. The overall length of the shield bridge is about 800 mm. The bridge will have a mechanical feature on both ends of each shell for connection to the thermal shields at the DFBX end and at the D1 end. (See Installation procedure [6].)

## 5.11 VACUUM VESSEL CONNECTION DETAILS

### 5.11.1 SEALING FLANGE

The sealing flange on the DFBX contains an O-ring; the groove details are shown in Figure 5.11-1. The design is similar in concept to that used by CERN elsewhere in the LHC.

**Figure 5.11-1 Sealing Flange O-ring Details.**

### 5.11.2 STRUTS FOR VACUUM LOADING

Since the supports for D1 can sustain an axial vacuum load, external tie bars will not be required to react vacuum loading as they are on the LQX side. The DFBX box will react thrust loads, once installed and positioned, via tie down brackets to the tunnel floor.



## 6. ELECTRICAL INTERFACES

### 6.1 MAGNET BUS BARS

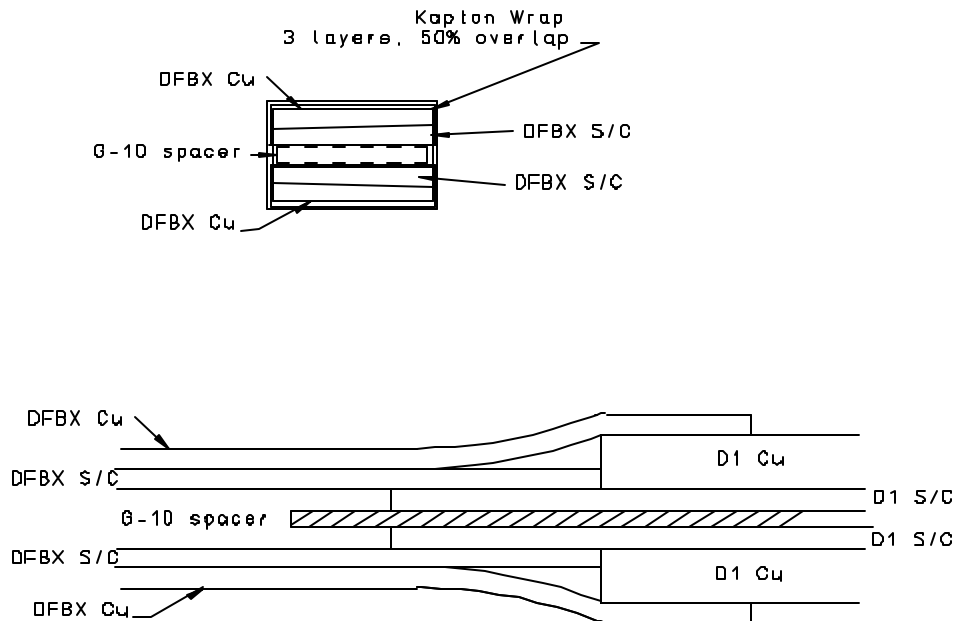
The DFBX bus bars that provide main magnet powering are contained in the duct designated MBX1. The fixed point for the bus bars on the DFBX side is the midplane of the DFBX LHe chamber. A spider from the DFBX side of the interconnect will support a block for mounting the insulated splice blocks at the interconnect. The spider will have holes to allow helium to pass through. The spider support allows longitudinal movement for thermal contraction.

The flexible bus in the MBX will have sufficient flexibility to accommodate the thermal expansion, as there is little flexibility in the DFBX bus. The MBX bus has an expansion loop.

**Table 6.1-1 MQX1 Power Busses**

Item	Insulated Bus Area (mm x mm)	Number of Busses	Test Voltage [7]	Free Length (m)
D1 Power Bus ( + )	16.5 x 3.6	1	1400	0.5
D1 Power Bus ( - )	16.5 x 3.6	1	1400	0.5

A sketch of the bus bar is shown in Figure 6.1-1. In the connection to the MBX bus, the conductors are spread apart and soldered in the interconnection region. Figure 6.1-1 also shows a longitudinal view of the interconnection. The solder joint will be soldered over the full transposition pitch. Strain relief is required at all connections; a bracket will be used to secure a splice block to support the connection.



**Figure 6.1-1 Cross-sectional view of the DFBX bus bar in the DFBX and longitudinal view of the DFBX bus bar connection to the D1 bus.**

## 6.2 MAGNET DIAGNOSTICS

The magnet diagnostic cables are given in [1] and are listed in Table 6.2-1. The connection will be made in a 25-mm diameter tube (MBX2) on the D1 end volume. The junction area will be sealed with a welded stainless steel tube. All wires are insulated with Kapton. Strain relief is required at all wire connections as specified in LHC-QI-ES-0001 [8].

**Table 6.2-1 Magnet Diagnostic Cables**

Item	Cable Type	AWG	Number of Cables	Test Voltage [7]	Free Length (m)
Voltage Taps	3-wire	28	2	1200	.5
Quench Heaters	2-wire	14	2	1200	.5
Thermometers	4-wire	32	2	200	.5
Phase separator liquid indicators (temp. sensors)	4-wire	26	2	TBD	.5

## 7. DRAWINGS

- a. FNAL 5520-MC-390056, LHC IRQ Shield Line Bellows Assembly.
- b. FNAL 5520-MC-390035, LHC IRQ Flange.
- c. FNAL 5520-MC-390061, LHC IRQ Cryostat Cool Down Line Bellows Assembly.
- d. FNAL 5520-MC-390033, LHC IRQ Flange.
- e. BNL 01055055, RHIC Interconnect Bellows.
- f. BNL 12140089, BNL flange m/c line.
- g. BNL 14010306, BNL flange i line.
- h. LHCLSX\_0003D, LHC Layout Drawings of Long Straight Sections, IR 2 Left
- i. LHCLSX\_0004D, LHC Layout Drawings of Long Straight Sections, IR 2 Right.
- j. LHCLSX\_0015D, LHC Layout Drawings of Long Straight Sections, IR 8 Left.
- k. LHCLSX\_0016D, LHC Layout Drawings of Long Straight Sections, IR 8 Right.
- l. Distributive Feedbox Schematic, LHCDFBX\_0001.
- m. LHCDFBX\_0010, Connections to D1 at IR2 left and IR8 Left.
- n. LHCDFBX\_0011, Connections to D1 at IR2 right and IR8 Right.

## 8. REFERENCES

1. LHC Interface Specification, "MBX Dipoles – D1", LHC-MBX-ES-0002.00.
2. LHC Interface Specification, "Inner Triplet Feedboxes: DFBX – Beam Tube", LHC-DFBX\_-ES-0220.00.
3. LHC Interface Specification, "Inner Triplet Feedboxes General Interfaces", LHC-DFBX\_-ES-0200.00.
4. LHC Interface Specification, "Inner Triplet Feedboxes: DFBX to LQXB", LHC-DFBX-ES-0210.00.
5. LHC Engineering Specification, "D1-Dipole Cooling Scheme", LHX-MBX-ES-0001.00.
6. LHC Engineering Specification, "DFBX Installation and Interconnection Procedure", to be prepared.
7. LHC Engineering Specification, "Voltage Withstand Levels for Electrical Insulation Tests on Components and Bus Bar Cross Sections for the Different LHC Machine Circuits", LHC-PM\_-ES-0001 rev 1.1, 31 August 2000.
8. LHC Engineering Specification, "Instrumentation Wires, Connection Techniques and Feedthroughs for the Main Arc LHC Cryomagnets and the QRL", LHC-QI-ES-0001 rev 2.0, 27 September 2000.

## **9. APPENDIX A – DEFINITION OF DFBX LOCAL COORDINATES**



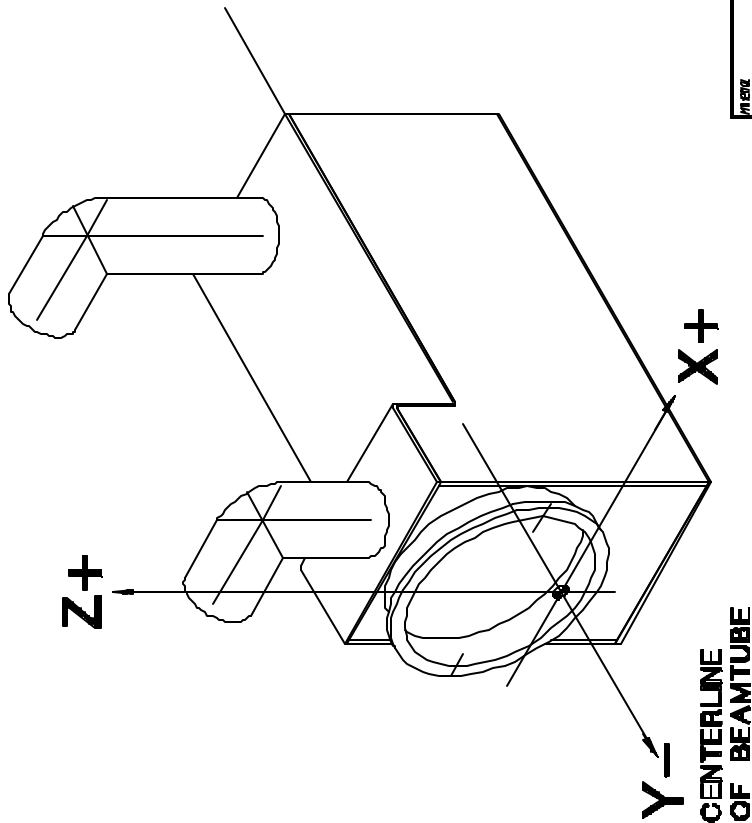
7) APPLICABLE FOR LEFT SIDE  
OF IPS 125.0.

THIRD ANGLE PROJECTION

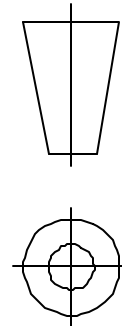
REV IN  
24C2971

NOTES: UNLESS OTHERWISE SPECIFIED.

- 1) X-0, Z-0, AT CENTER OF BEAM LINE.
- 2) Y-0 AT FRONT FACE OF FLANGE
- 3) POSITIVE X IS TOWARD THE MACHINE CENTER
- 4) POSITIVE Y IS A CLOCKWISE BEAM DIRECTION
- 5) POSITIVE Z IS VERTICAL UP FROM LHC PLANE.
- 6) CRYOGENIC PIPES, BEAMTUBE, CURRENT LEADS, ETC. OMITTED FOR CLARITY.
- 7) APPLICABLE FOR RIGHT SIDE OF IPS 1 2 5, 6.



THIRD ANGLE PROJECTION



REV	DATE	BY	COMMENT
1	01/01/00	XXX	INITIALS
LAWRENCE BERKELEY LABORATORY			
University of California - Berkeley			
LARGE HADRON COLLIDER, R FEEDBOX			
SPECIFICATION			
RIGHT SIDE CO-ORDINATE SYSTEM			
1	01/01/00	XXX	INITIALS
2	01/01/00	XXX	INITIALS
3	01/01/00	XXX	INITIALS
4	01/01/00	XXX	INITIALS
5	01/01/00	XXX	INITIALS
6	01/01/00	XXX	INITIALS
7	01/01/00	XXX	INITIALS
8	01/01/00	XXX	INITIALS
9	01/01/00	XXX	INITIALS
10	01/01/00	XXX	INITIALS
11	01/01/00	XXX	INITIALS
12	01/01/00	XXX	INITIALS
13	01/01/00	XXX	INITIALS
14	01/01/00	XXX	INITIALS
15	01/01/00	XXX	INITIALS
16	01/01/00	XXX	INITIALS
17	01/01/00	XXX	INITIALS
18	01/01/00	XXX	INITIALS
19	01/01/00	XXX	INITIALS
20	01/01/00	XXX	INITIALS
21	01/01/00	XXX	INITIALS
22	01/01/00	XXX	INITIALS
23	01/01/00	XXX	INITIALS
24	01/01/00	XXX	INITIALS
25	01/01/00	XXX	INITIALS
26	01/01/00	XXX	INITIALS
27	01/01/00	XXX	INITIALS
28	01/01/00	XXX	INITIALS
29	01/01/00	XXX	INITIALS
30	01/01/00	XXX	INITIALS
31	01/01/00	XXX	INITIALS
32	01/01/00	XXX	INITIALS
33	01/01/00	XXX	INITIALS
34	01/01/00	XXX	INITIALS
35	01/01/00	XXX	INITIALS
36	01/01/00	XXX	INITIALS
37	01/01/00	XXX	INITIALS
38	01/01/00	XXX	INITIALS
39	01/01/00	XXX	INITIALS
40	01/01/00	XXX	INITIALS
41	01/01/00	XXX	INITIALS
42	01/01/00	XXX	INITIALS
43	01/01/00	XXX	INITIALS
44	01/01/00	XXX	INITIALS
45	01/01/00	XXX	INITIALS
46	01/01/00	XXX	INITIALS
47	01/01/00	XXX	INITIALS
48	01/01/00	XXX	INITIALS
49	01/01/00	XXX	INITIALS
50	01/01/00	XXX	INITIALS
51	01/01/00	XXX	INITIALS
52	01/01/00	XXX	INITIALS
53	01/01/00	XXX	INITIALS
54	01/01/00	XXX	INITIALS
55	01/01/00	XXX	INITIALS
56	01/01/00	XXX	INITIALS
57	01/01/00	XXX	INITIALS
58	01/01/00	XXX	INITIALS
59	01/01/00	XXX	INITIALS
60	01/01/00	XXX	INITIALS
61	01/01/00	XXX	INITIALS
62	01/01/00	XXX	INITIALS
63	01/01/00	XXX	INITIALS
64	01/01/00	XXX	INITIALS
65	01/01/00	XXX	INITIALS
66	01/01/00	XXX	INITIALS
67	01/01/00	XXX	INITIALS
68	01/01/00	XXX	INITIALS
69	01/01/00	XXX	INITIALS
70	01/01/00	XXX	INITIALS
71	01/01/00	XXX	INITIALS
72	01/01/00	XXX	INITIALS
73	01/01/00	XXX	INITIALS
74	01/01/00	XXX	INITIALS
75	01/01/00	XXX	INITIALS
76	01/01/00	XXX	INITIALS
77	01/01/00	XXX	INITIALS
78	01/01/00	XXX	INITIALS
79	01/01/00	XXX	INITIALS
80	01/01/00	XXX	INITIALS
81	01/01/00	XXX	INITIALS
82	01/01/00	XXX	INITIALS
83	01/01/00	XXX	INITIALS
84	01/01/00	XXX	INITIALS
85	01/01/00	XXX	INITIALS
86	01/01/00	XXX	INITIALS
87	01/01/00	XXX	INITIALS
88	01/01/00	XXX	INITIALS
89	01/01/00	XXX	INITIALS
90	01/01/00	XXX	INITIALS
91	01/01/00	XXX	INITIALS
92	01/01/00	XXX	INITIALS
93	01/01/00	XXX	INITIALS
94	01/01/00	XXX	INITIALS
95	01/01/00	XXX	INITIALS
96	01/01/00	XXX	INITIALS
97	01/01/00	XXX	INITIALS
98	01/01/00	XXX	INITIALS
99	01/01/00	XXX	INITIALS
100	01/01/00	XXX	INITIALS

REV IN  
24C2971